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Do Producer Prices Cause Consumer Prices? Some Empirical Evidence

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Abstract

The main purpose of this paper is to examine the relationship between consumer price index (CPI) and producer price index (PPI) in Malaysia. This research considers monthly data of consumer price index and producer price index from January 1986 to April 2007. The Johansen cointegration method suggests that there is long-run equilibrium relationship between these two variables. Both Engle Granger and Toda-Yamamoto causality tests find that there is uni-directional causality running from PPI to CPI.

Keywords: Causality, Consumer price, Producer price, Malaysia

1. Introduction

This paper investigates the relationship between consumer price index (CPI) and producer price index (PPI) in Malaysia using monthly data over the period January 1986 to April 2007. Nowadays, empirical analysis on CPI and PPI relationship has received greater attention, as there are considered as indicators of inflation. The traditional or production chain view concerning the causal relationship between CPI and PPI is one in which changes in PPI lead or cause CPI as result of changes in producer prices which are passed on to consumers. This is merely a standard supply-side or cost-push explanation of changes in consumer prices. Colclough and Lange (1982) argue that an alternative view of the causal relationship between CPI and PPI which stresses the demand side seems equally plausible. According to this view, changes in the demand for final consumer goods exert an influence on input prices through the impact of changes in the prices of consumer goods on the derived demands for inputs. Uni-directional causality from CPI to PPI would characterize this particular viewpoint (Jones, 1986).

The directions of causality between CPI and PPI have been tested in many countries over various periods of time. The results have yielded conflicting evidence. For example, Caporale *et al*. (2002) investigated the causality issue using Toda and Yamamoto (1995) for G7 countries for the period January 1976 to April 1999. They found that PPI lead CPI in France and Germany. On the other hand, data of the United States suggest the result expected under the alternative view, which is CPI lead PPI. Data from Italy, Japan and the United Kingdom indicate feedback relations, whereas that of Canada fails to reveal any recognizable pattern.

Jones (1986) has examined causal chain among CPI and PPI in the United States using monthly data for the sample period January 1947 to December 1983, as well as for the two sub-samples, January 1947 to June 1971 and May 1974 to December 1983. The results reveal that there is a bi-directional causality between CPI and PPI.

Cushing and McGarvey (1990) indicated that feedback from PPI to CPI is greater than that from CPI to PPI from January 1952 through December 1987 in the United States. Recent study by Shahbaz and Nasir in Pakistan from January 1992 to June 2007 also found two way causality but stronger from PPI to CPI.

Mehra (1991) and Huh and Trehan (1995) study in the United States found that in the long run CPI leads labour cost, which is a major component of the PPI, a finding that contradicts the production chain view. Gordon (1988), on the other hand, analyzed data from 1954 to 1987 in the United States and concluded that there is no significant statistical relationship between CPI and PPI.

The motivation of this study is, at least very recently, most existing studies have been biased towards the larger and more developed countries. In addition, this is the first study that focuses exclusively in Malaysia. More technically, this research applies the modified-Wald test (MWald) test approached by Toda and Yamamoto (1995) to reinvestigate the causal relations between CPI and PPI.

The rest of the paper is organized as follows. In the next section, we give a brief discussion about the data set used in the present paper and outline the methodology employed. In section three we discuss the empirical results, while section four we provide concluding remarks.

2. Data and methodology

2.1 Data

In order to perform the causality analysis, we use monthly data for CPI and PPI (in 2000 prices). The data set was drawn for the period from January 1986 to April 2007, which comprises 256 observations in total. The variables are obtained from various issues of the International Financial Statistics (IFS) published by the International Monetary Fund (IMF) and transformed into natural logarithm scale prior to analysis.

2.2 Johansen Cointegration Tests

A preliminary issue regarding the methodological procedure is related to the fact that the data generating process for most of the economic series exhibits a unit root. Time series properties, namely order of integration and cointegration, have been examined by applying the full information multivariate procedure proposed by Johansen (1988).

The cointegration methodology basically characterizes the existence of a long-run relationship. According to Johansen (1988), a p-dimensional vector autoregression (VAR) of order k[VAR(k)] can be specified as follows:

$$Z_t = d + \prod\nolimits_1 Z_{t-1} + \ldots + \prod\nolimits_k Z_{t-k} + \omega_t (t = 1 \ldots T) \tag{1}$$

We can rewrite this expression as,

$$\Delta Z_t = d + \prod\nolimits_k Z_{t-k} + \sum_{i-1}^{k-1} \theta_i \Delta Z_{t-i} + \omega_t \tag{2}$$

Here Δ is the first difference operator, $\prod$ and θ are p-by-p matrices of unknown parameters and ω_t is a Gaussian error term. Long-run information about the relationship between CPI and PPI in Malaysia is contained in the impact matrix $\prod$. When the matrix $\prod$ has full column rank, it implies that all variables in Z_t are stationary. When the matrix $\prod$ has zero column rank, the expression is a first differenced VAR involving no long-run elements. If, however, the rank of $\prod$ is intermediate meaning that $0 < rank\ (\prod) = r < p$, there will be r cointegrating vectors that make the linear combinations of Z_t become stationary or integrated.

There are two Johansen cointegration tests. First, the maximum likelihood estimation procedure provides a likelihood ratio test, called a trace test, which evaluates the null hypothesis of, at most, r cointegrating vectors versus the general null of p cointegrating vectors. A second, likelihood ratio test is the maximum eigenvalue test, which evaluates the null hypothesis of r cointegrating vectors against the alternative of $(r + 1)$ cointegrating vectors.

2.3 Causality Tests

The hypothesis of non-causality can be tested in three ways depending on the order of integration. If the variables are integrated or order 1, denoted, I(1) and cointegrated, causality can be tested using the levels of the variables as in Equations (3) and (4) where the null-hypothesis of non-causality relates to the significance of φ and γ:

$$LCPI_t = \alpha + \sum_{i=1}^{k} \zeta_i LCPI_{t-i} + \sum_{j=1}^{l} \varphi_j LPPI_{t-j} + \varepsilon_t \tag{3}$$

$$LPPI_t = \psi + \sum_{i=1}^{r} \chi_i LPPI_{t-i} + \sum_{j=1}^{s} \gamma_j LCPI_{t-j} + \eta_t \tag{4}$$

Alternatively, if the variables are I(1) and cointegrated, the variables can be first-differenced (denoted Δ) and the error-correction term (ECM henceforth) from the cointegrating regression added as in Equations. (5) and (6). In this case, in addition to the significance of φ and γ, the significance of ξ and ϕ can establish the direction of causation:

$$\Delta LCPI_t = \alpha + \sum_{i=1}^{k} \zeta_i \Delta LCPI_{t-i} + \sum_{j=1}^{l} \varphi_j \Delta LPPI_{t-j} + \xi ECM_{t-1} + \varepsilon_t \tag{5}$$

$$\Delta LPPI_t = \psi + \sum_{i=1}^{r} \chi_i \Delta LPPI_{t-i} + \sum_{j=1}^{s} \gamma_j \Delta LCPI_{t-j} + \phi ECM_{t-1} + \eta_t \tag{6}$$

If the variables are I(1) and not cointegrated, the variables must be rendered stationary by differencing, as in Equations (5) and (6), but the test of causality does not include the lagged ECM term as Equations (7) and (8) show:

$$\Delta LCPI_t = \alpha + \sum_{i=1}^{k} \zeta_i \Delta LCPI_{t-i} + \sum_{j=1}^{l} \varphi_j \Delta LPPI_{t-j} + \varepsilon_t \tag{7}$$

$$\Delta LPPI_t = \psi + \sum_{i=1}^{r} \chi_i \Delta LPPI_{t-i} + \sum_{j=1}^{s} \gamma_j \Delta LCPI_{t-j} + \eta_t \tag{8}$$

In addition to the Engle-Granger approach (1987), we also employed a modified version of the Granger causality test to consider the robustness of the results based upon knowledge of the order of integration. This procedure was suggested by Toda and Yamamoto (1995) with the objective to overcome the problem of invalid asymptotic critical values when causality tests are performed in the presence of non-stationary series. Zapata and Rambaldi (1997) explained that the advantage of using the Toda-Yamamoto procedure is that in order to test Granger causality in the VAR framework, it is not necessary to pre-test the variables for the integration and cointegration properties, provided the maximal order of integration of the process does not exceed the true lag length of the VAR model. According to Toda and Yamamoto (1995), Toda-Yamamoto procedure however does not substitute the conventional unit roots and cointegration properties pre-testing in time series analysis. They are considered as complimentary to each other.

The Toda-Yamamoto procedure basically involves the estimation of an augmented VAR (k+d_{max}) model, where k is the optimal lag length in the original VAR system, and d_{max} is the maximal order of integration of the variables in the VAR system. The Toda-Yamamoto procedure uses a modified-Wald test (MWald) test for zero restrictions on the parameters of the original VAR (k) model. The remaining d_{max} autoregressive parameters are regarded as zeros and ignored in the VAR (k) model. This test has an asymptotic chi-squared distribution with k degrees of freedom in the limit when a VAR (k+d_{max}) is estimated. The dynamic causal relationship between prices and money supply would be as follows:

$$LCPI_t = \alpha + \sum_{i=1}^{k+d} \beta_i LCPI_{t-i} + \sum_{j=1}^{l+d} \gamma_j LPPI_{t-j} + u_t \tag{9}$$

$$LPPI_t = a + \sum_{i=1}^{m+d} b_i LPPI_{t-i} + \sum_{j=1}^{n+d} c_j LCPI_{t-j} + \upsilon_t \tag{10}$$

where *LCPI* and *LPPI* are, respectively, the logarithm of CPI and PPI, t is time period, k, l, m, and n is the optimal lag length, d is the maximal order of integration of the series in the system and u and υ are error terms that are assumed to be white noise. The initial lag lengths *k, l, m and n* are chosen using the Akaike Information Criteria. However, the initial lag lengths are augmented with extra lag(s) depending on the likely order of integration (d) of the series $LCPI_t$ and $LPPI_t$. If $LCPI_t$ and $LPPI_t$ is likely to be I(1) (as it is with most macroeconomic data) then one extra lag is added to each variable in Equations (9) and (10). If both variables are assumed I(0), no extra lag is added in the equation, and the Toda Yamamoto test is equivalent to the Granger causality test. Wald tests are then used to test the direction of causality. For example, in Equation (9), the lags of PPI_t, excluding the extra lag added to capture maximum order of integration, are tested for their significance. If the null hypothesis that the lags are jointly equal to zero is accepted, then PPI_t does not cause CPI_t. Testing for the joint significance of CPI_t, excluding the extra lag added, in Equation (10) allows tests for uni-directional or bi-directional causality.

3. Estimation results

The first stage involves establishing the order of integration using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP), with and without a deterministic trend. Table 1 presents the results of the unit root tests for the two variables, *CPI* and *PPI*. The results indicate that all the variables are not stationary in their levels. On the other hand, all data are stationary at first difference and therefore indicating that all variables are I (1).

Given the variables are I(1), the cointegration hypothesis between the variables is examined using the methodology developed in Johansen (1991) in order to specify the long-run relationship between the variables. The results of the cointegration tests are reported in Table 2. The null hypothesis of no cointegrating vector ($r = 0$) is rejected. Thus, CPI and PPI are cointegrated, indicated that there is a long-run relationship.

Because all the variables are I(1) and cointegrated, we transform the variables by taking their difference to induce stationary and test for standard Granger causality using Equation (5) and (6) with adding an error correction term lagged one period. Table 3 shows that there is statistical uni-directional Granger causality runs from PPI to CPI but there is no feedback causality from CPI to PPI.

To consider the robustness of this result the Toda-Yamamoto approach is also used. The results using this approach are presented in Table 4. Since all the variables are in levels, the results provide information about the long-run causal relationships among non-stationary variables in the system. The causality results are qualitatively the same as the results presented in Table 3. The results indicate that the null hypothesis that CPI do not Granger cause PPI cannot be rejected. These suggest that the PPI does not respond to lagged changes in CPI in the system. On the other hand, the hypothesis that PPI do not Granger causes CPI can be rejected at the 5 percent significance level.

4. Conclusions

This paper examined empirically the relationship between CPI and PPI for Malaysia. We employed monthly data and applied cointegration using the Johansen approach, application of standard Granger causality tests and the Toda-Yamamoto causality approach to study the CPI and PPI interaction. Using Johansen cointegration approach, our results show long-run association between CPI and PPI, in line with previous research in other countries (see for example Dorestani and Arjomand (2006)). This means that CPI and PPI move together in the long-run. Using standard Granger causality test and Toda-Yamamoto approach, we found evidence of a uni-directional link from PPI to CPI without significant feedback. The empirical evidence is consistent with the conventional wisdom that the causal relation between CPI and PPI is from the latter to the former, in line with Caporale *et al*. (2002) work in France and Germany.

Analyzing the relationship between the CPI and the PPI has been a target of many studies. The link is important since it allows policy makers to predict future inflation by using PPI. Through the analysis provided in this study, policy makers maybe better prepared to avoid, or at least mitigate, the negative consequences of inflation. This finding can help policy makers to rely more on the link between CPI and PPI and use changes in PPI to predict changes in CPI. Nevertheless, as shown in Caporale and Pittis (1997), leaving out “relevant” variables can invalidate causality inference. Therefore, we suggest that the significant of our results could possibly be improved upon by inclusion the money supply, real gross domestic product, and the interest rate aims at capturing the transmission mechanism of monetary policy.

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Table 1. Results of the Unit Root Tests

Panel A: ADF and PP Unit Root Tests at Level				
Variables	ADF		PP	
	τ_μ	τ_τ	τ_μ	τ_τ
LCPI	-1.3429 (12)	-1.2378 (12)	-0.5989 (4)	-0.8248 (4)
LPPI	0.1600 (1)	-2.8203 (1)	0.3153 (3)	-2.8668 (4)
Panel B : ADF and PP Unit Root Tests at First Difference				
Variables	ADF		PP	
	τ_μ	τ_τ	τ_μ	τ_τ
LCPI	-2.9565 (11)**	-3.1002 (11)	-14.3575 (3)***	-14.3462 (3)***
LPPI	-13.5459(0)***	-13.5448 (0)***	-13.5268 (1)***	-13.5271 (1)***

Notes: The null hypothesis is that the series is non-stationary, or contains a unit root. The rejection of the null hypothesis for both ADF and PP tests is based on the MacKinnon critical values. Values in parentheses are optimal lag lengths according to the Akaike Information Criteria and Newey-West Bandwidth. τ_μ and τ_τ are constant and trend and constant, respectively. Asterisk (***) and (**) denotes that a test statistic is significant at the 1% and 5% significance level, respectively.

Table 2. Testing for Bivariate Cointegration

H_0	H_1	Eigenvalue	Trace Statistics	5% Critical Value	Max-Eigen Statistics	5% Critical Value	VAR
$r = 0$	$r = 1$	0.1842	55.6030***	19.96	51.5122***	15.67	2
$r \leq 2$	$r = 2$	0.0160	4.0908	9.24	4.0908	9.24	

Notes: VAR is order of the variance. *** denotes statistically significant at the 1% level. H_0 and H_1 denote the null and alternative hypothesis respectively and r denotes the number of cointegrating vectors.

Table 3. Causality Tests Between Exchange Rate, Stock Prices and Interest rate: Engle Granger Approach

Dependent Variables	Independent Variables	Order of Lag	ECM_{t-1} (*t*-statistics)	Joint Test of Zero Restrictions of Variables Added in Column 2	
				F-Statistics	*p*-values
ΔLCPI	*ΔLPPI*	1	-2.1006**	6.1585**	0.0137
ΔLPPI	*ΔLCPI*	1	-1.1492	0.9273	0.3970

Notes: *Δ* denotes a first difference. ** denotes statistically significant at the 5% level. The lag length selection was based on Akaike criterion test results (not reported in this paper). ECM is the error correcting variable lagged one period.

Table 4. Causality Tests between Consumer Price Index and Producer Price Index: Toda-Yamamoto Approach

Dependent Variables	Independent Variables	Lag Structure	VAR Order	Joint Test of Zero Restrictions of Variables Added in Column 2	
				MWALD statistics	*p*-values
LCPI	*LPPI*	2	(3)	4.6047**	0.0109
LPPI	*LCPI*	3	(4)	0.9313	0.4262

Notes: The [k+d (max)] th order level VAR was estimated with d (max) =1 since the order of integration is 1. The lag length selection was based on Akaike criterion test results (not reported in this paper). ** denotes statistically significant at the 5% level.